ECONOMIC ASSESSMENT OF CONSERVATION AGRICULTURE OPTIONS FOR FAMILY FARMS IN BRASIL WITH A FARM HOUSEHOLD MODEL

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LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

Embrapa
Cerrados

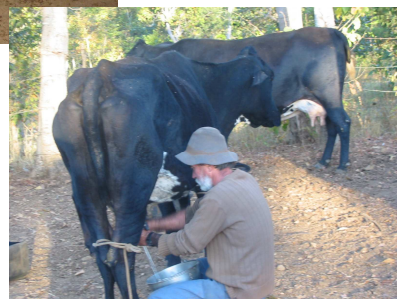
Outline

- Introduction: family farms in the Cerrados and Conservation Agriculture
- Objective
- Model – linear programming
- Results (so far)
- Conclusions

Introduction: family farms in the Cerrados

- Cerrados: savannah biome of Brazil (200 million ha)
- Sub-humid tropical climate
  - 1200 to 2000 mm rainfall from September to May
- Since the 1970s rapid expansion of large-scale commercial agriculture – 500 to 5000 ha and larger - located on the *chapadas*- Oxisols
- National Agrarian Land Reform Program – *assentamentos*: F.H. Cardoso government (1995-2002) redistributed some unproductive land to landless - family farms: 20 to 40 ha in the valleys on poor soils

Introduction: family farms in the Cerrados



- Diversity of farming systems – related to time since installation, rapidly evolving from subsistence farms towards more specialised, market-oriented dairy farms, the initial assets of the household, and the access to markets.

- Major farm types

Type	General Description	Animal production	Destination of the products
I	Subsistence agriculture without cattle	Small animals (pigs, chickens…); **No cows**	Self consumption + small-scale marketing
II	Subsistence agriculture with cattle	Small animals (pigs, chickens…), **1 - 10 cows**	Self consumption + small-scale marketing
III	Cheese producers	Small animals (pigs, chickens…), **2 - 11 cows**	Self consumption + small-scale marketing + cheese sale
IV	Milk producers (non exclusive)	Small animals (pigs, chickens…), **1 - 10 cows**	Self consumption + small-scale marketing + milk sale (1 -30 l/day)
V	Milk producers (specialized)	Small animals (pigs, chickens…), **4 - 35 cows**	Self consumption + small-scale marketing + milk sale (12-115 l/day)

Source: Adapted from Valadares, 2003 & Goudet, 2005

Introduction: conservation agriculture

based on 3 principles

1. absence of soil tillage or minimum tillage
2. maintenance of crop residues and/of a cover of crops at all times
3. use of suitable crop successions & rotations

Great agro-ecological potential:

- limits soil erosion
- Increases WUE (reduces water runoff, and soil evaporation)
- stabilizes crop yields by improving the condition of the soil (improves soil ecology)
- often increases labor productivity
- has several environmental benefits (soil C storage)

But CA has profound changes on farm management; economic gains are uncertain in case of family farms

As a result: high adoption by large, mechanized farms – low adoption by small farms

Objective of this study

- To understand the reasons for adoption or non-adoption of the CA systems
- An ex-ante analysis using a farm modeling approach, in order to answer the following questions
  - what are the impact of CA systems on net farm income?
  - which type of farmers (if any) were more likely to be interested in CA cropping systems?
  - which CA systems are the best-bet option?
- Construct a household model using linear programming (GAMS)
  - to reproduce the behavior of households which would have to select a set of crop, livestock and off-farm activities towards an objective and under the households' constraints with respect to available production factors and technical opportunities

Model: linear programming

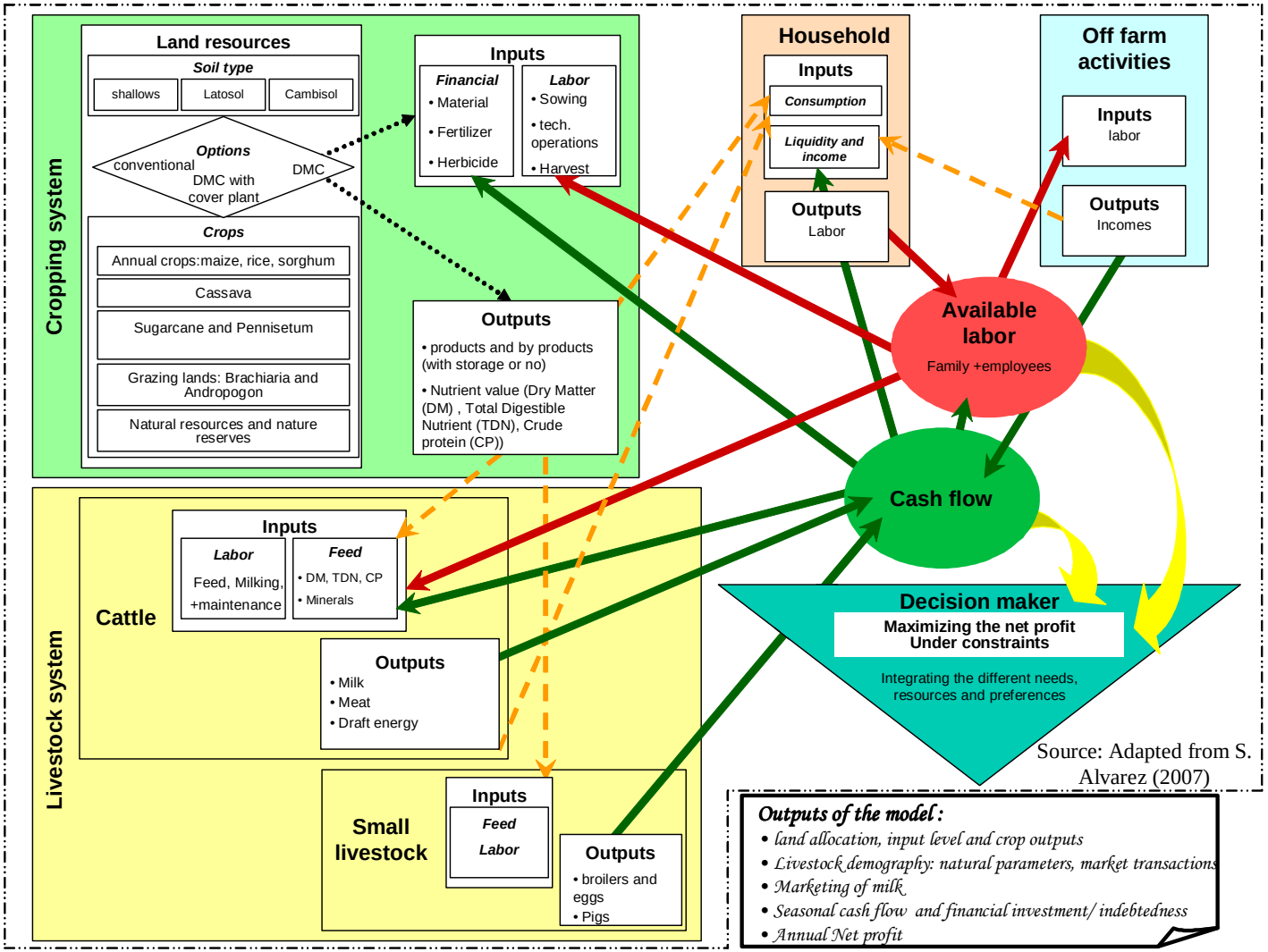
- Linear programming (LP) is a mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear equations.

- Objective function

$$U = \sum_{ye=t_0}^{T} \frac{C_{ye} X_{ye} + Y_T - \sum_{ra} \phi \lambda_{ra,ye} / card_{ra}}{(1+\tau)^{ye-1}}$$

- where: U the utility function for maximizing, C_t the vector of expected income from production activities in the year (ye), X_{ye} the vector of crop and livestock activities, Y_T the final stock of large ruminants, F the risk aversion coefficient, l_{ye} the variance of income according to the state of nature (*ra)*, *card* the cardinality of *ra*, T the planning horizon, and t the discount rate.
- Set of constraints related to limited availability of land, labour and cash, household needs in terms of food etc…(resource availability and needs for production, human and animal consumption)

Model



Source: Adapted from S. Alvarez (2007)

Study site and data

- Municipality of Unai, located at 160 km south-east of Brasilia
- *assentados* issued from the agrarian reform
- 3 innovative cropping systems for maize:
  - CA system with a mulch from the residues of the previous grain crop and no cover crop (baseline scenario);
  - two CA systems that incorporate fodder crops, i.e. *Brachiaria brizanta* or *Cajanus cajan*.
- The empirical data were collected from 6 farms representing 3 farm types of the study area:
  - 1) crop-livestock mixed farms mainly for subsistence;
  - 2) intensified market-oriented dairy farms with crossbreds; and
  - 3) less intensified dairy farms with Zebus.
- Empirical household surveys (data on income, labour availability and demand)
- Agronomic trials for the input-output matrix of the model.
- Information on livestock characteristics collected at each farm:.


Brasília
Lobby of the ultra-modern Hotel Blue Tree Towers
Luziânia
Unaí - MG, Brésil
Cristalina
© 2010 Cnes/Spot Image
Image © 2010 DigitalGlobe
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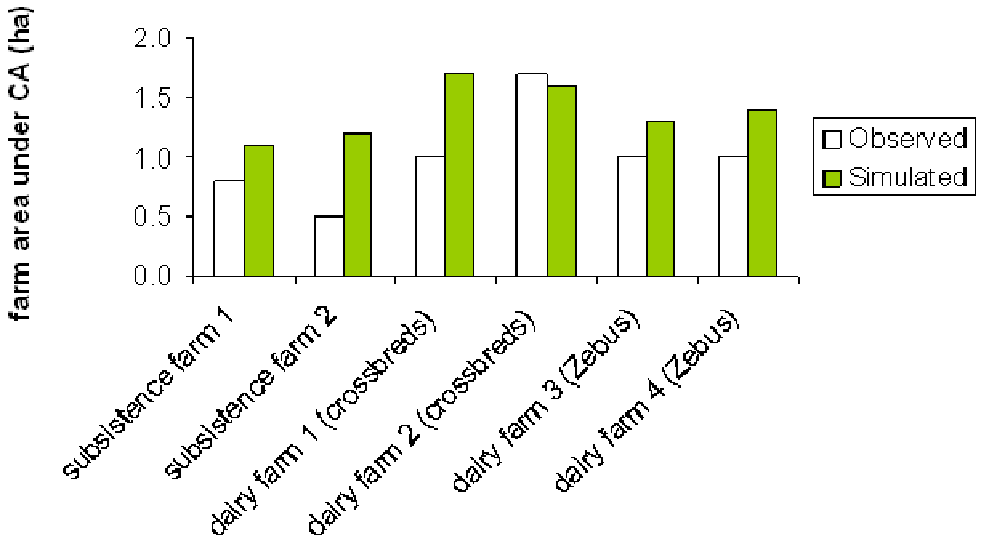
2009 Google
Altitude 178.84 km

Results: model calibration – base line scenario

- Comparison empirical and simulated farm area under CA

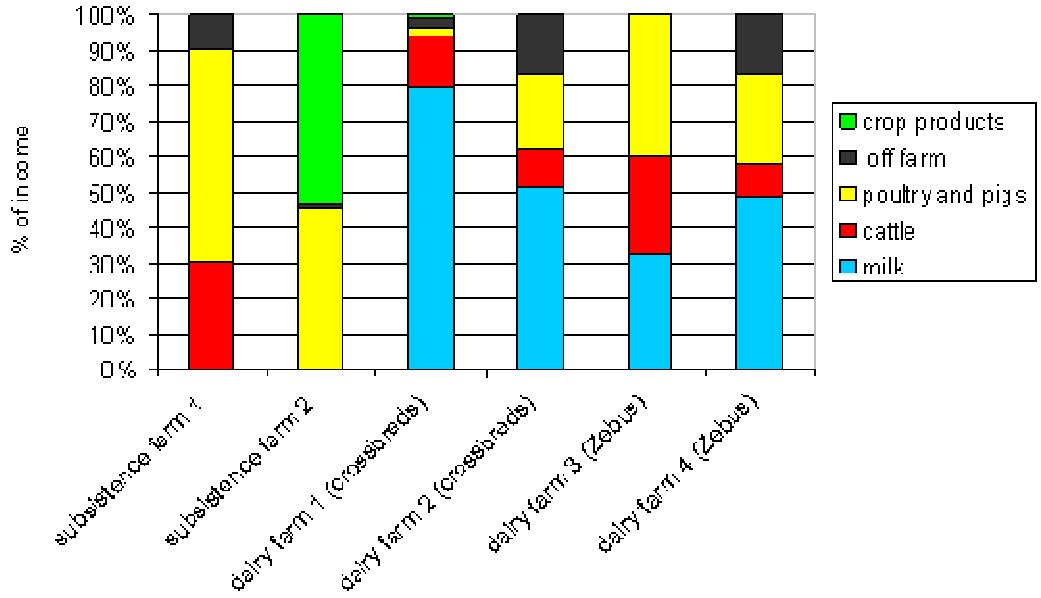


•Adoption of CA is mainly driven by savings in lab our and costs at planting of maize crop

•The ratio of the land area under CA over the total land area of a farm is related to the maize grain production on the farm, particularly for consumption by pigs and poultry.

Results: model calibration – base line scenario

- Simulated sources of income for the six farm of the study

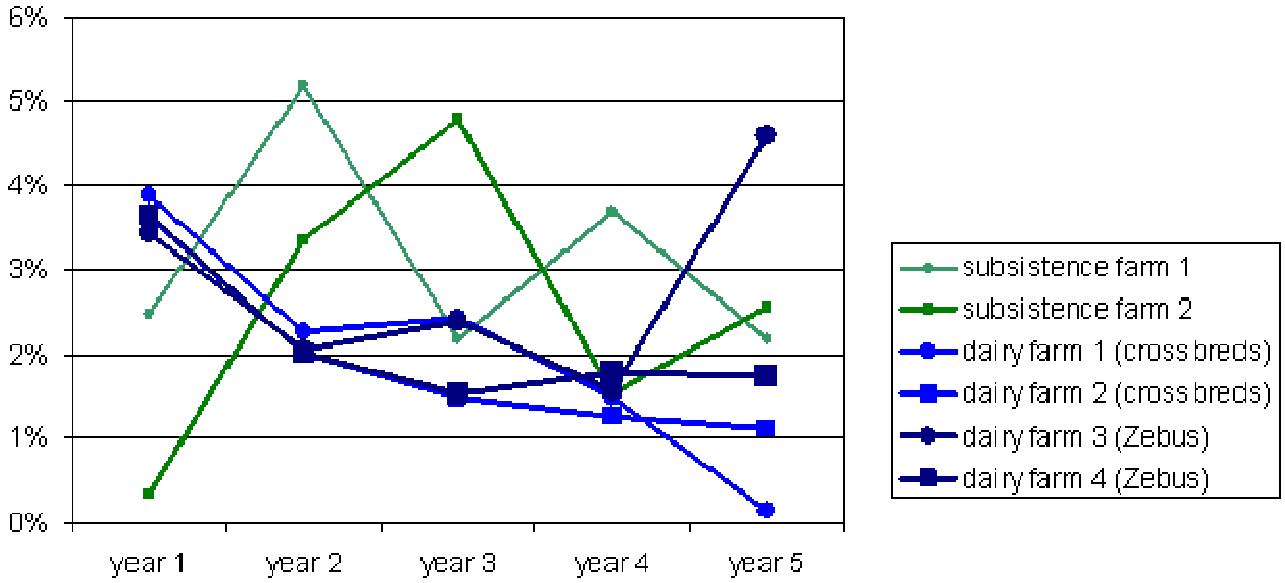


Results: scenario simulations

- Introducing CA with fodder cover crops: *Brachiaria brizanta* or *Cajanus cajan* in the farming systems without changing the marketing conditions of animal products
- Fodder crops are a source of additional animal feed (besides sugarcane and/or natural pasture) during the dry season that is much cheaper than the purchase of concentrates

Results: scenario simulations

- Increase in annual net farm income with the introduction of the CA systems with fodder cover crop (compared with the baseline scenario)



- CA system with *Cajanus* as cover plant is the best suitable option for all simulated farm types
- The subsistence-oriented farms registered the highest but also the most fluctuating income increases.
- The market-oriented dairy farms complement with concentrates.

Conclusions

- The adoption of CA by farmers in the *assentamentos* in the Cerrado region is motivated by the labour and cost savings during planting of the maize crop.
- CA based maize cropping systems with fodder as cover crops are compatible with the livestock activities on the farms, because of the limited availability of animal feed during the dry season.
- They facilitate the intensification of the farming systems towards milk production.
- Model predictions: CA based maize cropping system with *Cajanus* as cover crop is the best option for all the simulated farm types, depending on the yield and quality of the fodder crop
- When the dairy herd exceeds a certain threshold, the model suggests that the farmer prefers to use concentrates.